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National Aeronautics and Space Administration

FINAL TECHNICAL REPORT

FOR NASA GRANT NAGW-3945

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Title of Research: **"Fabry-Perot Spectroscopy in the Far Ultraviolet"**

Principal Investigator: Christopher Martin

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FINAL TECHNICAL REPORT FOR NAGW-3945

April 4, 1995

Since the time that the three-year award, NAGW-3945, "Fabry-Perot Spectroscopy in the Far Ultraviolet," was given to Prof. Martin at Columbia University, he has joined the faculty of Caltech, in Pasadena, California. He is in the midst of transferring his research program to Caltech, and will request that the second and third years of money for this program be made to him at Caltech. As a result, this is the Final Technical Report on NAGW 5-3945, which is the grant number at Columbia University. This is however, a report on a program that is still in progress. We expect to make future reports on this program using a new grant number at Caltech, where we will complete the program.

The following summarizes the accomplishments and status following the first year of the program "Fabry-Perot Spectroscopy in the Far Ultraviolet."

In the past year we: completed the design and fabrication of the etalon plates, designed the multilayer coatings for the plates and initiated plans for a mounting assembly of the far ultraviolet Fabry-Perot etalon. The Fabry-Perot etalon that we are building, is being designed to provide reasonably high transmittance at 155 nm ($\sim$ 25%), with a spectral resolution of 0.03-0.045 nm over a free spectral range of 0.6-1.0 nm.

The Fabry-Perot was initially designed to have a 50 mm clear aperture, on 70-80 mm etalon plates that were to be polished to better than $\lambda/120$ and less than 1 nm surface roughness. We obtained UV grade MgF_2 for these plates from Optovac, Inc, and sent the

plates to be polished by Continental Optical Corp. Originally, Continental Optical was the only optical shop that felt that they could achieve the required specifications. However, in order for them to interferometrically test the matching of the plates, they needed to "flash coat" the plates with a reflecting surface in order to measure the properties of the polished surface with reasonable signal to noise. They found, however, that each cycle of "flash coat" followed by coating removal seriously degraded the surface roughness to nearly an order of magnitude above our specification. Since they were thus unable to test the optics, they could not match the plates successfully and they withdrew from the job.

A sub-contractee of Queensgate, Ltd, England, which had initally "No bid" the etalon polushing job, had since that time gained some experience with Magnesium Fluoride plates and felt that they could polish Magnesium Fluoride to our required specifications. They worked on a new set of Magnesium Fluoride material purchased from Optovac, Inc. The set of plates they polished included one 70 mm diameter plate and a 50 mm diameter plate optically contacted to a 70 mm diameter support plate. This design would provide a 35-40 mm clear aperture, somewhat smaller than the design to which Continental Optical was working (we had relaxed our aperture requirement). Columbia had also purchased from Optovac a set of 10 mm diameter Magnesium Fluoride spacers which helped facilitate the polishing and which provide spacing information that will be useful when the plates get assembled in their mechanical fixture. Queensgate's polisher performed the optical contacting and the matching of the plates and delivered the polished product in March, 1995. The optical contacting took several tries but eventually the plates bonded successfully. Plate flatness interferograms show their quality to be exceptional, with plate flatness

of $\lambda/150$ at 633 nm. The pair of matched plates are now ready to receive a reflective all-dielectric multilayer coating.

The all-dielectric multilayer coating requires better than 80% reflectance at 155 nm, <%4 absorptance and approximately 10 nm bandwidth. In addition to achieving the required optical performance, this coating must be applied so that it has little effect on the figure of the polished plates. An RFQ for this coating was sent to Acton Research Corporation and to Dr. Muamer Zukic at the Optical Aeronomy Laboratory at the University of Alabama in Huntsville. Acton "No bid" the coating, but Dr. Zukic at UAH felt that he could achieve the requirements. He bid on the job, which not only includes the multilayer coating but also requires that several reflecting aluminum spots be coated along the perimeter of the plates so that the etalon can be aligned easily in its mechanical mount.

Finally, we initiated the design of a mechanical mount fixture which would be capable of supporting the parallel plates in a fixed position, even following vibration loads incurred during launch of a sounding rocket. We have had several discussions about the design of this fixture with Queensgate, although they have not yet formally quoted the job.